

# Assessing Personality Traits in a Large Scale Software Development Company: Exploratory Industrial Case Study

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**Abstract.** Software development methodologies become increasingly more people and team-oriented. However, many software projects fail due to conflicts of team members. Formation of an effective software development team may be particularly challenging given the differences inherent across an individual's personality. This paper explores personality traits of agile software development teams by using a context-specific interactive assessment. Concerning the assessment, we have conducted a questionnaire with 110 participants from a large-scale software development company. We have visualized personality traits with team radar charts showing the personality traits of 18 project teams and analyzed the results by validation interviews. Our preliminary results indicate that higher introversion is observed most commonly in isolated teams that has less contact with customers. Moreover, high levels of agreeableness and conscientiousness personality traits are observed in most of the agile software development teams.

**Keywords:** Software Team Visualization; Agile Software Development; Personality Assessment; Industrial Case Study

## 1. Introduction

Traditionally, the effectiveness of software development was considered as a result of critical factors such as inherent intellectual abilities [1] and the programming experience of practitioners [2] [3]. Many different agile methodologies are becoming more preferred over traditional approaches, with their critical emphasize on collaboration during software development. Instead of focusing on following a plan in the software development process, the focus is more on people and their interactions [4]. Due to this common underlying principle, it demands on the social and interpersonal abilities of software practitioners which are greatly influenced by their personality traits [5]. Moreover, many research has shown that team performance is greatly influenced by personality traits of personality traits of software practitioners [6] [7] [8]. In particular, a few study found that the composition of a team is effecting a team's performance [9] [10]. Ultimately, personality profiles of members are seen as important predictors of organizational success [11].

Therefore, to understand and manage higher levels of interaction among software practitioners, it is important to note that individuals may have different personality traits. Benefits of this awareness may bring from maximizing productivity, delivering in a timely and cost-effective manner, to the satisfaction of all stakeholders [12]. Moreover, it may help software practitioners to form a team effectively, to prevent incompatibilities, and ultimately improve team motivation. Although the significance of the need to explore human aspect is widely acknowledged and seen as an important factor that affects team performance, there is not much research devoted to investigating the personality traits compositions for an effective team [13]. Only a few research has emerged with a focus on personality traits over software team configuration [7]. In particular, there is not much study that relates personality traits with selecting a suitable software development methodology.

With the above in mind, the overall goal of this industrial case study is to understand how software development teams' personality trait configurations with an aim to explore effective team configurations that bring the potential benefits listed above. Furthermore, personality characteristics of a team may work better for agile software development practices. For instance, managing successfully changing requirements, having strong communication with customers, and working as a cross functional team. We aim to reveal and illustrate personality characteristics by using an interactive (game-like) assessment based on context specific questions [14].

Concerning this goal, we derived the following research questions:

RQ1: How the software practitioners' personality traits are distributed according to the Big Five Inventory (BFI) [15] dimensions in software development teams? With this question, we intend to learn about practitioners' personality inclinations.

RQ2: How are the personality traits of software development teams configured? We want to know whether the software development teams' personality traits could be demonstrated to get more insights.

RQ3: Do the personality traits of software development teams has an effect on team performance? We want to understand how personality traits are related to team progress. Further, we want to understand which personality traits are perceived as most relevant by practitioners and whether there is an effective configuration for better team performance.

RQ4: How the visualization of personality traits could be used in the software development processes? We want to explore possible benefits and usage of personality research.

The selected assessment approach was proven to be a reliable method to explore the personality traits using the same set of software practitioners using five factor model [16]. This approach has been selected because of several factors. Firstly, the model uses a set of contextual questions based on the situations faced at software domain, which presents familiar concepts to practitioners and assists to retrieve achieve more accurate judgment. This type of assessment was the only example in the software engineering field and published on recognized journals. Moreover, this approach was relatively easier to implement in a large-scaled software company via its systematic manner and interactive game concepts.

The remainder of the paper is organized in the following manner. Section II provides an overview of the personality types and traits research background. The section III details the methodological approach we used to conduct the case study. The next section gives details analysis of the assessment results and illustrations of overall team characteristics. Section V provides a discussion of the findings that emerged from the study. On the section VI, the suggestions for future work are discussed before concluding.

## 2. Related Work

In this section, we briefly consider background research addressing the personalities in relation to software development. Personality trait significantly affects human behavior [17], and it is a steady characteristic of human behavior in a wide variety of situations [18]. The Big Five Inventory (BFI) is one of the widely used models to organize individuals according to their personality traits in considering five factors (i.e. Openness, Conscientiousness, Extroversion, Agreeableness, and Neuroticism) [15].

**Openness to experience** evaluates the tendencies for creativity and curiosity [19]. People who are open to experience tend to be, when compared to closed people, more creative and more aware of their feelings. They enjoy new experiences and adventures.

**Conscientiousness** is a tendency to show self-discipline and aim for achievement against outside expectations. This trait denotes people who are well-organized, committed with a sense of duty and pursuing excellence in their work [20]. It is also related to the way in which people control, regulate, and direct their impulses.

**Extroversion** trait is spotted by engagement with the external world. Extroverts enjoy social interactions with others with high group visibility. They like to talk, and assert themselves and are often perceived as full of energy and enthusiasm.

**Agreeableness** trait is related with showing altruistic concern as well as being gentle, helpful and trustful. Agreeable individuals give value to getting along with others. Agreeable people also have an optimistic view of human nature.

**Neuroticism** is the tendency to negative emotional experiences such as sadness, anxiety, anger and depression, and they may show emotionally instable behaviors [21]. People who score high in neuroticism are emotionally reactive and vulnerable to stress. Also, this trait is connected with having a pessimistic approach toward work.

## 2.1. Personality Research in Software Engineering

A reasonable amount of studies has been conducted to understand individuals' personality type in software engineering [22]. In addition, a number of studies has attempted to assess different personality types in groups and its impact on their relationships with each other and influence on team performance [23] [24] [25]. Considering the openness to experience personality trait, Salleh et al. [26] found a substantial impact of openness to experience on performance. Moreover, Neuman and Wright [27] also discovered a relationship between openness to experience and team performance. On the other hand, Van Vianen and De Dreu [28] observed no significant relationship.

Balijepally et al. [19], demonstrated that conscientiousness is important for success of a team. In another study, Acuna et al. [8] showed that there is a significant connection between conscientiousness and autonomy, and job satisfaction. Whereas, Salleh et al. [26] found no significant effect of conscientiousness on team performance. Balijepally et al. [19], also found that agreeableness, and extroversion were important for success of a team.

In their study, Salleh et al. [26] also found that there is no significant effect of neuroticism on team performance. Another study has attempted to investigate the personality characteristics of software practitioners by constructing Personality-Team Radars and concluded that effective teams consisted of teams of individuals which show a higher degree of emotional stability, agreeableness, extroversion, and conscientiousness personality traits. Moreover, they observed that agile teams were found to be more extroverted [15]. In our study, we aim to observe extroversion at the assessed teams. On the contrary, Rodrigues and Rebelo [29] claimed that there is no connection between big five personality traits and team performance. Baumgart et al. [20] found that agreeableness is the most important factor for the Developers when they investigated the important personality factors of the different roles in Scrum teams for a successful team performance. In this study, we want to explore this connection.

In consideration of team compositions, Neuman and Wright [27] found a positive effect of variability in emotional stability and team performance. Capretz et al. [30] advocated that when dealing with the dynamic tasks of a software development process, a team with unique perspectives should be beneficial. They further concluded that certain combinations of personality type are likely to work better during a software engineering project [30]. Another similar results were suggested by Choi et al., 2008 and Sfetsos et al., [31] who found out that diversity of personality attributes leads to better performance.

In a recent empirical study, Capretz et al. [32] indicated that personality characteristics are related to role choices in software development activities. Therefore, it shows that team performance might be improved by regarding personality types when assigning responsibilities to team members. Cockburn [33] suggested that agile software development projects' outcome is largely affected by the fit team member's personality profile to the assigned role besides his/her ability to effectively perform.

To sum up, earlier research attempted to explain the differences between social behaviors of software practitioners such as collaboration, aggression, cooperation, and interactions with other individuals. These efforts on personality confirm that the notion of personality assessments in the software engineering processes appears to be open to more investigations. Considering all these remarks, the research on personality area may help us to understand the differences among the practitioners and create potential benefits to improve team performance. For instance, some combinations of the personality characteristics of a team may be more suitable for a specific development practice, and

this can be used for selecting methodologies for different teams and different projects. In this industrial case study, we aim to explore the personality traits of software development teams.

### 3. Research Methodology

In this section, we provide a detailed explanation of the overall research methodology. We have used a case study approach which is identified as an applicable methodology for empirical research in software engineering context [34].

#### 3.1. Selected Company for the Industrial Case Study

In order to assess personality traits in a large-scale software development organization, an industrial case study was carried out at HUAWEI Turkey Research and Development Center (HTRDC). HTRDC is a well-established large software development company works in Turkey with around 500 engineers. Historically, started its R&D presence in Turkey over 10 years and software development process maturity was certified with maturity Level 5 of Capability Maturity Model Integration for Development (CMMi-DEV). Inevitably, to reach and continuously provide a value-driven approach both for the customer and for the organization the necessity of agile transformation is emerged to get its technical and commercial benefits. While agile transition in this company is getting accelerated by more teams choosing agile methodologies, the interest to research on factors affecting agile team performance is high. This company was primarily chosen due to its interest to improve their organizational productivity via receiving more information about software team structures and personality characteristics of teams.

#### 3.2. Research Process

This sub-section describes main steps we have followed during our research:

1. Firstly, as we have defined our hypothesis based on our research questions as *the personality characteristics of software development practitioners and team configurations based on the personality characters can be explored and demonstrated by interactive assessment technique at a large scale company*.
2. After a careful review of the literature and different methodologies we have decided to use an interactive (game-like) approach for our assessment [14].
3. Next, we have evaluated the context cards, which consists of contextual questions based on the situations at software domain, that were proposed by the selected approach in terms of clarity, readability, and relevance by a series of sequential activities. By that, we have refined the assessment approach with a pilot group of participants.
4. Next, we have conducted the personality assessment with 110 software practitioners in 18 sessions with different teams at the company.
5. Based on the collected data, we have demonstrated personality traits on radar charts and evaluate the collected data by comparisons based on individuals' project teams, roles, age, and experience levels.
6. In addition, we have collected key performance indicators of effective teams and we have compared our initial observations from the radar charts.
7. Finally, we have performed validation interviews with team leaders and analyzed our preliminary findings with them.

#### 3.3. Personality Assessment Procedure

In order to initiate our research, we have got approval from senior management of the company to conduct assessments. Firstly, with a pilot group we have run few pilot with 60 context cards [14]. Based on the feedback, context cards were translated to Turkish by translation experts for better understandability. Also, to improve interest and to get more accurate results from the participants, we have transferred questions to an online survey

platform which has also a set of interactive game elements. The assessments were started with an introductory talk, as we have exposed this study as an analysis of the personality traits to agile software development. Practitioners were invited to participate voluntarily in our assessment with their project team members to a meeting room isolated from the work environment. Also, several personal information such as work experience, age, and software development methodology were collected without any disclosure.

Each question and its picture were shown on a big screen on the online survey and questions were read by the moderator (See Figure 2). Participants have answered the questions via selecting one of the two options on each question simultaneously. Participants were encouraged to interact and discuss the details of any questions. To summarize, this interactive approach was enabled us to discover not only the personality characteristics of individuals but also the personality structure of the software teams as a whole.



**Fig. 1.** A snapshot from the assessment screen.

## 4. Results

In light of the case study method that is described on the previous part, we came up with personality traits of individuals and software development teams. In the following subsections, we have explained our analysis.

### 4.1. Descriptive Analysis of Personality Assessments

In the company, we have conducted our industrial case study we have surveyed 110 software practitioners from 18 project teams who were available to participate. We have attempted to explore personality traits accurately using a percentage scale. Moreover, in order to see the distribution and inclination of personality traits of the assessment participants, we have given letter grades (e.g. VH, H, M, L, and VL) to specified ranges of scores. Table 1 gives an overview of participants in the assessments with the descriptive results and letter grade distribution.

**Table 1.** Percentage results of the assessment participants versus their personality traits.

	Descriptive Results				Letter Grade Distribution				
	M	SD	Min	Max	VH	H	M	L	VL
<b>A.</b>	61%	15%	25%	92%	28%	18%	45%	3%	2%
<b>C.</b>	54%	16%	17%	92%	12%	25%	42%	15%	3%
<b>E.</b>	39%	12%	17%	67%	0%	3%	53%	23%	18%
<b>N.</b>	44%	12%	17%	75%	1%	4%	64%	16%	12%
<b>O.</b>	44%	12%	8%	67%	0%	5%	58%	22%	11%

a. M., Mean; SD, Standard Deviation; Min, Minimum; Max, Maximum; VH., Very High Range 100% - 70%; H., High Range 69% - 60%; M., Medium Range, 59% - 41%; L., Low Range 40% - 31%; VL., Very Low Range 30% - 0%; A., Agreeableness; C., Conscientiousness; E., Extroversion; N., Neuroticism; O., Openness to experience.

Practitioners have shown average values, that is, relatively higher levels of the agreeableness (61%) and conscientiousness (54%). Whereas, the mean value for extroversion (39%) was relatively lower than the expected high levels of extroversion. This scores makes it harder to confirm hypotheses such as those found in other studies that relate agile team performance negatively to introversion [14]. This preliminary finding may be linked to the ongoing transition of the company to agile methodologies.

Through the letter grade view, we were able to observe the inclination on extroversion dimension to the VL range (18%). Besides, 28% of the participants were on the VH range on the scale in agreeableness dimension, and almost half of the population (46%) were on the high levels on this trait. Second most inclination to VH and H levels were observed on the conscientiousness trait with 37% in total. On the openness and neuroticism traits, the most of the participants were in the medium range on the percentage scale (64% and 58%), with more inclination to lower levels on these traits than the high levels.

In order to get more insight, we have grouped employees according to their roles, years of experience in software engineering and age groups. As shown on Table 2, quality and operation team members (QAE and CME) have shown the highest levels in extroversion trait, which may be a result of that the process group is at a position that highly interacts with many different teams. In contrast, the average extroversion of testers was the lowest which may be caused by immature adaptation of testers to a cross functional team structure. The overall low levels at extroversion trait which were less than 50%, may be the result of having less interaction directly with customers due to the ongoing agile transformation. Openness to experience trait was found to be compatible for agile development which is related with a detail oriented mindset and good communication and innovation skills [33]. In our assessment, developer leads and project managers have showed highest levels of openness, whereas the rest of the participants have shown low levels of openness to experience. Also we have observed project managers and test leaders possess high conscientiousness, as were expecting this result as it supports their role requirements.

**Table 2.** Roles of assessment participants versus group details and average percentage of their personality traits.

Role	#	A. Age	A. Exp.	A.	C.	E.	N.	O.
PM	8	33,9	9,5	61%	66%	41%	45%	54%
Dev.	46	25,9	3,0	56%	52%	39%	43%	42%
Dev. Lead	6	30,3	8,7	67%	50%	44%	56%	54%
Tester	17	27,6	3,1	61%	50%	28%	40%	40%
Test. Lead	5	31,0	6,2	60%	65%	32%	42%	43%
SE	7	29,9	5,9	65%	62%	35%	48%	45%
QAE	13	27,8	4,3	72%	55%	54%	42%	45%
CME	8	27,0	2,4	69%	49%	48%	49%	48%

a. PM, Project manager; Dev, Software developer; D. Lead, Development Leader; Tester, Software Tester; T. Lead, Test Leader; SE, System Engineers; QAE, Quality Assurance Engineer; CME, Configuration Management Engineer; #, Group size; Age, Average age; Exp. Average years of experience; A., Agreeableness; C., Conscientiousness; E., Extroversion; N., Neuroticism; O., Openness to experience.

After the role based analysis, we have analyzed the participants according to their age groups and experience levels which are shown on Table 3. We have observed that neuroticism personality trait level of the sample was higher among the older ages, and we have observed an increasing trend on this trait as the age and the years of experience increases. The high scores on neuroticism is associated negative emotional states. This may be the result of taking more responsibilities as the experience level increases and for instance, it may bring anger and anxiety. Also, an increasing trend is shown on the openness to experience personality trait as the experience level increases. Moreover, significant increase at the sample means was observed at conscientiousness personality trait for the group of more than 35 years old in comparison with 30-34 years age group.

**Table 3.** Roles of assessment participants versus group details and average percentage of their personality traits.

	Age Group				Exp. Level			
	20-24	25-29	30-34	35+	0 to 2	2 to 4	5 to 9	10+
A.	59%	61%	62%	64%	56%	63%	64%	63%
C.	52%	55%	52%	75%	54%	54%	54%	58%

<b>E.</b>	38%	43%	35%	39%	39%	43%	36%	40%
<b>N.</b>	42%	46%	43%	56%	43%	45%	43%	51%
<b>O.</b>	39%	44%	48%	47%	39%	45%	47%	51%
<b>#</b>	<b>24</b>	<b>48</b>	<b>35</b>	<b>3</b>	<b>30</b>	<b>37</b>	<b>36</b>	<b>7</b>

a. Exp. Level, Experience Level; #, Group size; A., Agreeableness; C., Conscientiousness; E., Extroversion; N., Neuroticism; O., Openness to experience.

#### 4.2. Personality Measurements and Visualization of Personality Profiles in Effective Software Development Teams

To investigate software development team characteristics and their relationship with personality traits, apart from individual qualifications (i.e. roles, overall experience levels, and ages) we have considered team attributes. We have collected a series of information such as teams' development methodology, team size with the individuals' functionalities, iteration length, complexity of their work and the technology they are currently developing, and frequently used best practices in software development. In consideration of these information we selected five software teams based on the availability of their progress metrics of teams, also, their team sizes that are between 5 to 9 members.

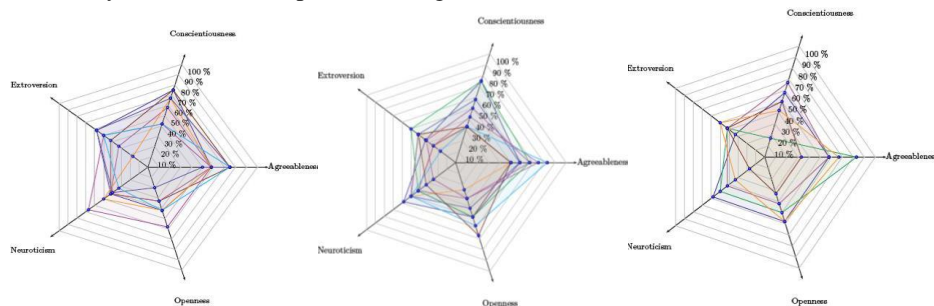
In order to help our evaluations, we have selected key performance indicators to collect from teams such as team velocity (in terms of story points completed in an iteration), productivity (number of user story points completed per person day effort), predictability (compares the number of user stories completed with the number of committed user stories), workload deviation (as the percentage deviation from the planned workload) and defect density (in terms of defect count per user story point). KPIs are collected from the last 5 sprints of the teams that are outlined on Table 4.

**Table 4.** Selected software development teams versus their key performance indicators.

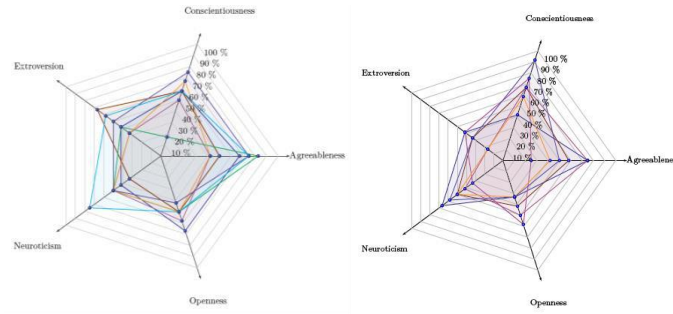
Team	#	A.	C.	E.	N.	O.	TV	Prod.	Pred.	WLD	DD
<b>Team B</b>	9	62%	48%	34%	44%	45%	26	0,19	56%	0%	0,47
<b>Team G</b>	7	65%	61%	44%	45%	43%	25	0,25	100%	11%	1,24
<b>Team M</b>	5	60%	47%	42%	40%	48%	26	0,24	NA	35%	1,86
<b>Team N</b>	7	62%	55%	46%	50%	52%	63	0,99	96%	0%	0,50
<b>Team P</b>	6	54%	67%	31%	50%	42%	7	0,03	36%	12%	5,61

a. #, Team size; A., Agreeableness; C., Conscientiousness; E., Extroversion; N., Neuroticism; O., Openness to experience; TV, Team Velocity; Prod., Productivity; Pred., Predictability; WLD, Workload Deviation; DD, Defect Density.

Except Team N other teams were using scrum and Team N was using iterative development life cycle. Team P was taking advantage of continuous integration (i.e. release automatic software builds, tests) to remove obstacles early. Teams B, G and P were working on new and complex technologies, instead of maintenance projects. All of the teams were performing daily stand-up ceremonies, sit together, some of them use other agile practices such as planning poker for estimating and planning. In light of all, we have plotted the calculated percentages of the personality traits of each person by using a Personality-Team radar template as in Figures 2-6.



**Fig. 2.** Team radar for Team B. **Fig. 3.** Team radar for Team G. **Fig. 4.** Team radar for Team M.



**Fig. 5.** Team radar for Team N. **Fig. 6.** Team radar for Team P.

By the means of team radar-charts we were able to see teams' personality trait distributions visually and we were able to use this tool to get insights about the inherent differences in personality combinations of different team. Moreover this tool allowed us to see individual traits together with the team members instead of an average value. The overall distribution on team radars were fairly balanced (i.e. overall personality characteristics of all teams are in the inner webs of the agreeableness, extroversion, openness, and conscientiousness traits).

#### 4.3. Validation Interviews

To arrive at a deeper understanding of the personality traits and to investigate the possible use of our findings, semi structured interviews [34] were conducted by the first author with team leaders from each team. Each participant was interviewed separately and interview forms were filled based on the answers orally given by the interviewee. The average duration of the interviews were about half an hour. During the interviews, questions were asked to understand how software practitioners perceived their team and individual personality traits and their effects on team performance. We have asked about team structures such as teams' contact to customer, emotional stability of the teams when coping with pressure and stress, and the patience and motivation to work on complex or long term repetitive tasks, tolerance to slow velocity and changing requirements, thoughts on following standard procedure.

Next, we have also asked questions regarding the benefits of the revealing software development teams' personality characteristics. We have asked whether they think personality traits may help to improve their team productivity to some extent. Finally, we presented them our preliminary results and asked whether they agree or not. The collected answers from the assessment were enclosed during the interviews and not shared with the team leaders. Participants were expected to give a score to each of our extractions on a 5-point scale ranging from 1 (Strongly disagree) through 2 (Disagree), 3 (Neutral), 4 (Agree) to 5 (Strongly agree). We have agreed on an acceptable level of the extraction validity and identified the valid and questionable extractions.

### 5. Results Dissemination And Discussion

The interpretation of the interview results suggest that the introverted individuals were not taking proactive actions to slow velocities, they would expect a goal from their managers. Whereas extrovert practitioners were seen as relatively intolerant to slow project velocities. This was more significant on teams that do not have any contact with customer. Interviewees have stated that most of the teams showed intolerance to continuously changing requirements. This could be a result of people who possess high conscientiousness do not like continuously changing requirements and they prefer to follow standard procedures when encountered with problems. This result was compatible with observed high levels of conscientiousness trait of the teams. Another interviewee has mentioned that their team is somewhat tolerant to changing requirements, yet, they would not handle changes easily with using scrum in a situation when they work more closely with a customer rather than working on a R&D project.



Additionally, the extroverted seen to be in a team leader position and they are keen to contribute to the team social structure and improve process performances. Some participants stated that practitioners who were found higher on the extroversion and openness to experience traits, give more input to how the process would have been improved and they would have been more interested in selection of the type of software development processes. Also, they thought that Scrum methodology may not be convenient to employees that are more introverted.

The sample population was highly conscientious, whereas less extroverted, the most of the teams were likely to be more result-oriented and less interested in process improvement. Participants suggested that, by adding an opposite personality character to a team that cannot list improvement items confidently in their retrospection ceremonies, would subtly ignite the improvement focus of a team. Others suggested that, understanding personality traits and their interactions with each other would be effective for identifying and separating conflicting personalities in teams.

In summary, the preliminary findings of this study proposed that the sample population holds low levels of extroversion personality characteristics which might be the underlying reason of conflicts during the agile transformation. Ultimately, most of the interview participants stated that they have not encountered with visualization of software team personality traits. They have strongly agreed that revealing the personality structure of a software development team could be very beneficial. Our efforts contributed to consideration of personality characteristics of software practitioners and teams.

### **5.1. Limitations and Threats to Validity**

In this part, we discuss a few limitations of this study and the potential threats to validity. This study was limited by the sample population individuals who participated voluntarily from one large-scale company. Hence, the results might not be similar to other software companies. During the study, all of the private information (e.g. names, project names) was modified through all transcripts to protect confidentiality. Apart from these limitations, personality assessment relied on subject dependent statement. Therefore, likewise the all kind of personality tests our study involves the possibility that participants report false choices. For the sake of increase the possibility of accurate answers, we have used game elements and an interactive approach. Moreover, we have refined the assessment method by translating questions to mother language of participants in order to collect more accurate answers. Nevertheless, the authors believe that this exploratory study presents interesting insights, and findings would be compared with further studies in different settings with more software teams. Apart from these limitations, this study showed an exemplary successful use of a personality assessment, and contributed to the understanding of personality traits of software practitioners and teams.

## **6. Conclusion**

Human factor is widely acknowledged as it has a significant impact on software projects' success. However, it may increase the inherent complexity of software development activities [35]. In this industrial case study, we explored personality characteristics of software development teams at a large-scale company by making use of assessing individual personality traits with an interactive assessment approach. For this purpose, we conducted an industrial case study that includes a series of interactive personality assessments, extraction of personality radar charts of teams, comparison of the assessment results with team's key performance indicators and validation interview sessions with team leaders. Consequently, we were able to get insights about how socially compatible teams could be formed through getting more knowledge with personality assessments and Personality-Team Radars.

We, firstly, observed high levels of agreeableness and conscientiousness at majority of the individuals. Secondly, overall distribution on team radars were fairly balanced (i.e. overall personality characteristics of all teams are in the inner webs of the agreeableness, extroversion, openness, and conscientiousness traits). Surprisingly, our findings show

that, teams were found to have low levels of extroversion. This may be not problematic for the teams that have low levels of interaction with customers. However, since the company is planning to transit to agile methodologies, the low levels of extroversion may cause problems. This research has contributed to increase awareness to take preventive actions for future problems that may be caused by selecting unsuited methodology for a team's characteristics.

To summarize, we believe that effort to deeper understanding of personality traits may be beneficial particularly for software development organizations. Personality traits of individual and teams should be assessed to proactively benefit from the effective team configurations that may lead to better team performances and also prevent team based conflicts, especially in large scale software organization. Moreover, as the personality traits of the employees affect the organizational culture, taking them into consideration as part of SPI manifesto [36] is crucial in order to attain engagement. As future work, we intend to complement our findings and the impact of personality traits with statistical analyses. Further studies to explore personality combinations that may work better and to validate our findings can be conducted. Moreover, we would like to explore effective methodology selection according to personality traits of the software development teams. An automated software development methodology selection tool based on personality traits could be built to suggest possible methodologies and practices to software management. This would help to choose practices with a greater degree of suitability to the team.

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